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The impact of extension and ecosystem services on smallholder's credit constraint

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ABSTRACT

On formal credit markets, access to formal credit and reasonable credit terms of smallholder farmers in rural sub-Saharan Africa is limited due to adverse selection. Financial institutions operating in rural areas often cannot distinguish between borrowers (farmers) that are creditworthy and those that are not, thus, allocate limited resource to agriculture to reduce credit risk. In the presence of limited business quality signaling by smallholder farmers, financial institutions shall demand for collateral and/or offer unfavorable contract terms. Moreover, agricultural productivity of rural sub-Saharan Africa, dominated by subsistence or small-scale farmers, is also negatively impacted by the adverse effect of climate change. A strategy that may make the farming practices of smallholder farmer's climate resilient and profitable may also improve smallholder farmer's access to formal credit. This study investigates to what extent participating in ecosystem and extension services (EES) programs signals business quality of smallholders, thus granting them credit accessibility. We collected data on 210 smallholder farmers in 2013, comprising farmers that receive payments for ecosystem services (PES) and farm management training from the International Small Group Tree Planting Program (TIST) Kenya to test the aforementioned theory empirically. We use game theory, particularly a screening and sorting model, to illustrate the prospects for farmers with EES to access formal credit and to improve their credit terms given that they receive PES and banking services training. Furthermore, the PES' long term duration (10 – 30 years) generates stable cash-flow which may be perceived as collateral substitute. Results suggest that smallholder farmers in the TIST program were less likely to be credit constraint compared to non-TIST farmers. Distance to market, education, livestock and farm income are factors that determine access to credit from microfinance institutions in rural Kenya. Amongst farmers that have obtained loans, those keeping business records enjoy more favorable formal credit conditions. These farmers were observed to pay ca. 5 percent less interest rate in microfinance charges. For TIST farmers, this type of farm management practices may be attributed to the banking services and other training they receive within the program. While the availability of classical collateral (farmlands) and PES may reduce interest rate, the *latter* was found to be statistically insignificant. This research underlines the importance of an effective extension services in rural areas of developing countries and the need to improve gains from conservation agriculture and ensuing PES. The benefits associated with EES and PES may encompass agricultural financing.

JEL Classifications: D2, D8, G2, Q1, Q2

Keywords: Financial institution, credit risk, ecosystem services, smallholder farmers, sub-Saharan Africa.

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INTRODUCTION

In parts of sub-Saharan Africa, agricultural small and medium enterprises (SMEs) are confronted with credit constraints; in some developing countries over 50 per cent of farm households are formal credit constrained (Muayila and Tollens, 2012; Simtowe et al. 2009; Blackman 2001). In a situation where credit for agricultural investment is not available, agricultural development is hampered by the absence of modernization, proper marketing channels, and

cash management (Barry and Robison, 2001). Limited lending by formal financial institutions to rural agricultural SMEs can, in part, be attributed to information imperfection i.e. lenders are unable to observe which borrowers are involved (Sacerdoti 2005; Benjamin 2013a; Su, 2012). Information asymmetry, moral hazard and covariant risk associated with smallholder farmers compounded by lack of adequate collateral are considered incalculable risks for banks (Swinnen and Gow, 1999). However, there is a potential strong demand for agricultural credit in developing countries (Swinnen and Gow, 1999).

In general, information asymmetry (adverse selection) and moral hazard combined, is always an issue in credit demand, however, increasing the interest rate and collateral requirement results in financial institutions having a pool of bad clients and risky projects, ultimately yielding a reduction in bank return (Stiglitz and Weiss, 1981). Limited liability causes borrowers to invest in projects with relatively higher risk corresponding to higher payoff; increasing the interest rate would result in less risky projects being crowded out due to a low payoff, thus, credit rationing of high risk projects (Wette, 1983). Increasing the liability of borrowers through a higher collateral requirement as a means of credit allocation increases the riskiness of the loans as borrowers cannot offer the required collateral (Stiglitz and Weiss, 1981). Collateral requirement is therefore not used as a rationing tool to eliminate excess demand if borrowers are risk averse and risk neutral, as this may also lead to adverse selection, therefore reducing lenders' profit (Stiglitz and Weiss, 1981; Wette, 1983). These authors argue that amongst observationally identical borrowers in a single-contract equilibrium scenario given a level of (excess) demand, some receive loans, while others are denied loans due to randomized selection. Banks therefore choose an optimal interest rate for all borrowers with limited liability, which remains unchanged even in the presence of excess credit demand (Stiglitz and Weiss, 1981). The model of Stiglitz and Weiss (1981) has been criticized for considering interest rate and collateral a separate entity rather than a simultaneous incentive process from a sorting perspective. An interest rate/collateral combination may lead to incentive-compatible contracts, which segments risk-making rationing insignificant as adverse selection is eliminated. Random rationing also depends on the evaluation of the project in the borrowing pool; a positive elevation of a project by both bank and borrower does not lead to adverse selection, thus the validity of risk-sorting. Therefore borrowers that may have been denied loans due to collateral constraints are no longer the result of random rationing (Su, 2012). Collateral is accepted by a financial institution if it is valuable enough to mitigate the risk of the advanced loan, while banking policies may also reduce the number of high-risk borrowers (Swinnen and Gow 1999).

It is important to explore new approaches in dealing with information imperfection in agricultural credit risk in order to foster rural development, for instance considering new forms of client evaluation, collateral and insurance policies (Boucher et al., 2008; Barry and Robison, 2001). Extension services with ecosystem services (EES) may help overcome the aforementioned information imperfection. The projects embarked on by the EES participants are mostly well documented due to monitoring, verification and reporting requirements. Thus comprehensive records are available on the business cycle, agricultural output, as well as all possible revenue sources of individual smallholders (Masiga et al. 2012). These schemes are often run by non-governmental organizations (NGOs) and provide training on ways to improve agricultural productivity through knowledge spillovers along with helping to generate additional income from payment for ecosystem services (PES). For example, the *International Small Group Tree Planting Program* (TIST) trains small and medium farmers on conservation techniques, including zero tillage, (organic) fertilizer application, mulching, terracing, climate change mitigation through tree planting, and rainwater harvesting. In addition, farmers receive assistance from TIST in accessing formal credit. This kind of program not only improves farmers' human capital, especially skills related to record-keeping and farm management, but also introduces carbon certification as an additional source of income (Tham-Agyekum et al. 2010; Pagiola et al. 2005). EES have led to improvements in/and diversification of farm revenues among adopting farmers (Kagwiria 2013). Ecosystem and conservation farming by smallholders in developing countries contributes to the alleviation of poverty by helping farmers accumulate capital (Pagiola et al. 2005; Montagnini and Nair 2004). Moreover, carbon certification demonstrates that agricultural SMEs have already self-financed part of their project therefore sending a positive business quality signal (Benjamin 2013b).

This study investigates the impact of smallholder participation in EES on credit constraints and credit conditions in the case of Kenyan TIST participants. Participation may have beneficial effects since higher incomes, more diversified sources of income, and an extra source of collateral (future income from carbon sequestration) may lower risk premiums charged by financial institutions. In addition, skills provided through the TIST network may be perceived by financial institutions as an indicator of business viability and trustworthiness. We use the model of Han et al. (2009) to investigate whether farmers can be sorted into quality groups that are offered different contract types, using EES as a quality measure, and test the implied effects empirically using a novel data set on Kenyan smallholders' credit market performance.

The remainder of this article is structured as follows: Section 2 introduces the theoretical framework of the sorting and screening model and develops the hypotheses. Section 3 elaborates on relevant data used in this study. Section 4 carries out an econometric regression in order to verify the hypotheses. Section 5 concludes.

THEORETICAL MODEL

The model described by Han et al. (2009) combines two previous theoretical models: Berger and Udell (1990) and Bester (1985). The former model argues that financial institutions may require collateral from and/or impose higher interest rates on observed risky borrowers (Sorting by observed risk), whereas the latter argues that the creditworthiness of borrowers is screened via the collateral put up by borrowers (Sorting by private information). As both are important possible mechanisms we use the combined model of Han et al. (2009) to illustrate a multiple-contract equilibrium scenario. An alternative model would be that of Milde and Riley (1988), but they use loan size to screen participants, rather than observable characteristics.

As pointed out by Lambrecht (2009), Han et al. (2009) use the term signaling, which is an unfortunate choice, as they have in fact a sorting and screening model.¹ Borrowers are sorted according to observable characteristics and then screened through a menu of contracts. Thus we will refer to observable characteristics. To stay consistent with the notation of Han et al. (2009) we will denote the characteristics as s .

In their article, Han et al. (2009) assume that financial institutions know the return on a project but are not familiar with the business ability of borrowers. Therefore, these formal institutions sort clients based on an observed characteristic. Examples of such characteristics are business records and involvement in EES both of which can be observed by the lender without significant cost. One issue with observable characteristics is that they do not perfectly measure quality, thus borrowers who seem to have a high degree of creditworthiness may in fact not be very creditworthy.

Following Han et al. (2009) we model farmers with and without EES who demand credit for a farming project. This farming project requires an exogenous investment (K) which is completely financed by formal institutions. The success of the farming project depends on the farming ability θ of the farmer with a probability $p(\theta)$. Highly-skilled farmers are denoted by θ_H and low-skilled farmers denoted as θ_L . $\{\theta_H, \theta_L\} \in (0,1)$. A farmer repays if the project is successful and defaults if it fails. The probability of project success is equal to farming ability of the farmer $p(\theta) = \theta$. Credit contract is made up of interest rate r and collateral C where repayment of credit $= (1+r)K$. The Project (farming) return is:

$$return = \begin{cases} (1+\theta)K \rightarrow \text{with probability } (w.p.) \rightarrow \theta \\ 0 \rightarrow \text{with probability } (w.p.) \rightarrow (1-\theta) \end{cases}$$

The utility function of the farmer at the end of the period for a successful project for a farmer with EES is ($U^{S|EES}$) = (Initial wealth (W) + potential cash flow from carbon credit (B) + project return – credit repayment:

$$U^{S|EES} = (W + B) + ((1+\theta) K) - (1+r) K = (W + B) + (\theta - r) K$$

w.p. θ .
Similarly for a conventional farmer:

$$U^{S|Conventional} = (W + ((1+\theta) K) - (1+r) K = W + (\theta - r) K$$

w.p. θ .

In case the project fails we have (U^F) \rightarrow Initial wealth – Collateral pledge (due to default):

$$U^{F|EES} = (W + B) - C$$

w.p. $1 - \theta$.

$$U^{F|Conventional} = W - C$$

w.p. $1 - \theta$.

Thus the expected project utility (EU) is:

$$EU^{EES} = \theta U^{S|EES} + (1 - \theta) U^{F|EES} = (W + B) + \theta^2 K - r\theta K - (1 - \theta)$$

$$EU^{Conventional} = \theta U^S + (1 - \theta) U^F = W + \theta^2 K - r\theta K - (1 - \theta)$$

Prior to the sorting process the bank estimates that the distribution of farmers over types is equal, i.e. $P(\theta_H) = P(\theta_L) = 0.5$. Moreover, the bank assumes that the probability of observing a high-quality characteristic of a highly-skilled farmer, \bar{s} , is equal to that of observing a low-quality characteristic of a low-skilled farmer, \underline{s} , i.e., $\Pr(\bar{s} | \theta_H) = \Pr(\underline{s} | \theta_L) = \alpha$. The conditional probabilities of observing the respective characteristic from the different types of farmers are:

$$\Pr(\theta = \theta_H | s = \bar{s}) = \Pr(\theta = \theta_L | s = \underline{s}) = \frac{0.5\alpha}{0.5\alpha + 0.5(1 - \alpha)} = \alpha,$$

and

$$\Pr(\theta = \theta_L | s = \bar{s}) = \Pr(\theta = \theta_H | s = \underline{s}) = 1 - \alpha$$

The latter conditional probability represents the case of a low skilled farmer participating in a conservation program, i.e., the probability of a low-skilled farmer having a high-quality characteristic and vice versa. The conditional probability α is assumed to be ≥ 0.5 . If α is less than 0.5 then s is not a good measure of quality. With better information, formal institutions could design contracts for each type of farmer. Thus the bank offers two types of contracts: one for highly-skilled farmers $\Gamma(r_H, C_H)$ and one for low-skilled farmers $\Gamma(r_L, C_L)$. Assuming separate contracts, the expected profits of the bank are, in the case of High quality characteristics:

$$E\bar{\pi} = \alpha [\theta_H(1+r_H)K + (1-\theta_H)C_H - K] + (1-\alpha) [\theta_L(1+r_L)K + (1-\theta_L)C_L - K] \quad (9)$$

a. Low quality characteristics:

$$E\pi = (1-\alpha) [\theta_H(1+r_H)K + (1-\theta_H)C_H - K] + \alpha [\theta_L(1+r_L)K + (1-\theta_L)C_L - K] \quad (10)$$

Self-selection Mechanism and Screening

Bank contracts can screen individuals and promote self-selection if two conditions are satisfied: *individual rationality* and *incentive compatibility*. For both lender and farmer, the *individual rationality* condition states that if the expected utility of undertaking the project is larger than the utility of not undertaking it then the project will be undertaken. Given W for conventional farmers and $W + B$ for the sustainable farmer, it follows that the menu of contract for borrowers, given the expected utility of the project, under the individual rationality condition is:

$$\begin{aligned} EU_i^{EES}(\Gamma_i) &= (W + B) + \theta_i^2 K - r\theta_i K - (1 - \theta_i)C \geq \\ W + B &\rightarrow \theta_i^2 K - r\theta_i K - (1 - \theta_i)C \geq 0, \end{aligned} \quad (11)$$

Similarly the expected utility of conventional farming project is:

$$EU_i^{cv}(\Gamma_i) = W + \theta_i^2 K - r\theta_i K - (1 - \theta_i)C \geq W \rightarrow \theta_i^2 K - r\theta_i K - (1 - \theta_i)C \geq 0 \quad (12)$$

For the formal financial institution this condition implies:

$$E\bar{\pi} \geq 0 \text{ if characteristic } s = \bar{s} \text{ and } E\pi \geq 0 \text{ if the characteristic } s = \underline{s}$$

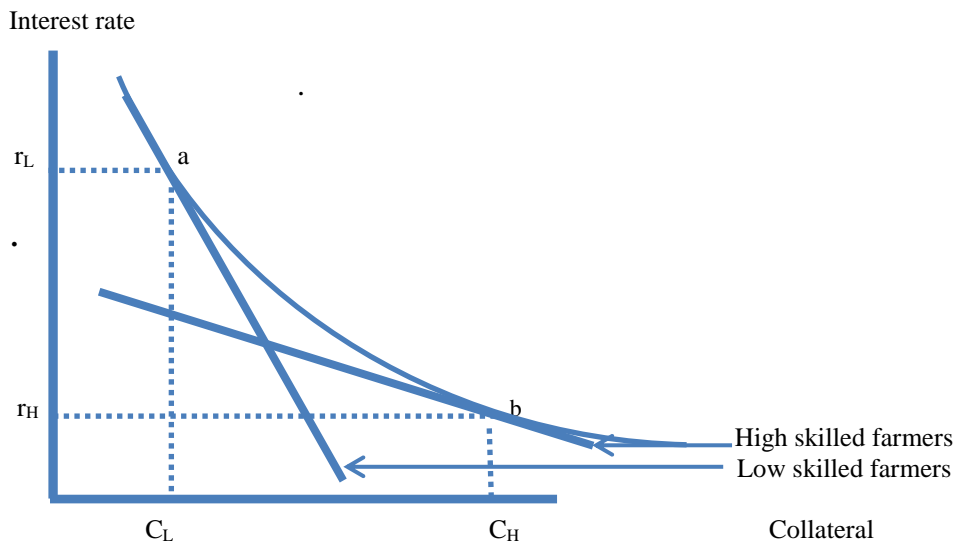
For farmers, the *incentive compatibility* ensures that it is optimal to choose contracts meant for them and not to opt for the other contract, i.e. for a high-(skilled) quality farmer $EU_H(\Gamma_H) > EU_H(\Gamma_L)$ and low-quality farmers $EU_L(\Gamma_L) > EU_L(\Gamma_H)$, for both of those sorted into the EES and conventional group. To further elaborate on the farmer's participation condition, a *high-skilled* farmer who has a high-quality characteristics \bar{s} will maximize his expected utility by choosing a combination of low interest rate and high collateral such that $EU_{HEES}(\Gamma_H) > EU_{HEES}(\Gamma_L)$, and a low skilled farmers high-quality characteristics \bar{s} such that $EU_{LEES}(\Gamma_H) > EU_{LEES}(\Gamma_L)$. The same condition holds for conventional farmers. Under the *individual rationality* and *incentive compatibility* conditions contracts can be designed such that, given the characteristics, farmers are separated into high- and low-quality. In order to separate, the bank needs to offer for each type of characteristic two types of contracts such that

$$\begin{cases} \text{if } r_L > r_H & \text{then } C_H > C_L \\ \text{if } r_L < r_H & \text{then } C_H < C_L \end{cases} \quad (\text{Proof: see Benjamin, 2015}).$$

The intuition is that each type of farmer will settle for the contract that matches their skills. Within the EES group the contracts separate the low skilled farmer from the high skilled ones, and the same occurs in the conventional group. However, high skilled farmers with EES probably face even better contract terms than high skilled without EES.

The separation mechanism is illustrated in figure 1, which depicts the marginal (dis)utility of interest rate and collateral between low-skilled and high-skilled farmers.

FIGURE 1. MULTIPLE CONTRACT EQUILIBRIUM



Source: Han et al. 2009. Subscripts denote farmer's type.

Note: Depicted are Indifference curve in r and C from Bank's perspective and for two types of farmers in a choice contract

Depicted are the indifference curves in $r - C$ for both the bank and the two types of farmers. On the y-axis of the graph are the interest rates r of the farmers, and on the x-axis is the collateral requirement. For credit terms, low-skilled farmers maximize their utility at point "a" while highly-skilled farmers maximize utility at point "b". From the above graph (Fig. 1) it is obvious from the indifference curve that a highly-skilled farmer would prefer collateral to interest rates, as this set of farmers is willing to pledge more collateral or assets for a substantially lower rate of interest. In contrast, a low skilled farmer has an opposite preference therefore pledging less collateral for a high interest rate.

DATA

The study area covered includes the Eastern and Rift valley provinces (Embu, Meru and Nanyuki) characterized by humid, semi-arid and arid climatic condition located in central and western Kenya. In 2013 we surveyed smallholder farmers from each of these regions who were both member as well as non-members of The International Small Group Tree Planting (TIST) program. TIST is undertaking projects in conjunction with the Clean Air Action Corporation's (CAAC), a private carbon developer, to establish small-scale agroforestry. These projects not only help in the afforestation of

farmlands such that they are more productive but also validate and verify carbon sequestration according to the verified carbon standard (VCS) and the Climate, Community and Biodiversity standard (CCB) (Shames et al., 2012). TIST creates small groups of farmers to organize the tree planting and provides training in Kenya and have so far established tree cover on an estimated 4,597 ha, sequestering 209,613 tons of carbon in 2012 (Masiga et al., 2012). A total of 210 farmers were interviewed, 70 smallholders from each of the 3 location, drawn from a group stratification of villagers using proximity to TIST meeting point as reference. The stratification was based on distance to TIST meeting areas which were ≤ 1 kilometer; ≤ 5 kilometer; and ≥ 5 kilometer. Smallholders farm size ≤ 2.5 were predominant throughout with ca. 56 per cent of them growing cash crops such as coffee or/and tea. Furthermore, maize, vegetables, beans, livestock, potatoes and agroforestry are some of the other major agricultural produce.

EMPIRICAL ANALYSIS

Table 1 shows a reduction in the number of observations to 130 due to incomplete information. Summary statistics show that 88 per cent of all interviewees report to have been able to obtain a loan, whereas 12 per cent were not. However, it is important to mention that we cannot be certain about the correct interpretation of “0” statements, since we cannot distinguish perfectly between individuals whose application for credit had been rejected, those that did not try to obtain credit because they might have anticipated rejection and those that had not been in need of credit by the time of the interview. Approximately 42 per cent of smallholders stated that they keep written business records while average farm size and cattle were 1 hectare and 2, respectively. Average total revenues among 130 smallholders is approximately 114,000 Kenyan shillings (Ksh); average distance to the nearest market is approximately 2.1 km. Education, measured in years of formal schooling, is 8.8 years.

TABLE 1. DESCRIPTIVE STATISTICS (REFERING TO MODELS SHOWN IN TABLE 3)

<i>Variables</i>	<i>N</i>	<i>Mean</i>	<i>Standard Deviation</i>	<i>Min.</i>	<i>Max.</i>
Credit access (Yes/no)	130	0.88	0.30	0.00	1.00
Maintain business records (Yes/no)	130	0.42	0.50	0.00	1.00
Cattle (Head)	130	1.52	1.61	0.00	15.00
Farm size (Hectares)	130	1.00	2.00	0.05	16.00
Total revenues (000 Ksh)	130	114.74	113.11	8.20	730.00
Education of farmer (years)	130	8.75	3.68	0.00	16.00
Distance to market (Km)	130	2.08	2.94	0.01	20.00
TIST member (Yes/ no)	130	0.66	0.48	0.00	1.00
Neighbor is TIST member (Yes/ no)	128	0.82	0.39	0.00	1.00

In table 2a and 2b, descriptive statistics of successful and unsuccessful applicants are presented, respectively. A comparison of information with those who failed at accessing credit markets (table 2b) reveals that there are substantial differences between these groups' socioeconomic indicators: successful applicants tend to have approximately 2.4 times more cattle, larger farms (factor 1.7), and substantially higher revenues (factor 2.7) compared to unsuccessful ones. They attend school longer (by more than three years), and are located closer to the nearest market (on average 1.8 km compared to 4.3 km). This indicates that some farmers might fail at accessing credit markets because they are less solvent, have less collateral or because they are less skilled. Surprisingly, successful applicants were less likely to keep written records

compared to unsuccessful applicants (42 per cent versus 47 per cent), and are more likely to be a member of TIST. Given the variety of potential reasons for credit market access, it is at this stage impossible to identify one particular reason. We will shed more light on this matter by assessing these factors simultaneously in a multiple regression framework.

TABLE 2A. DESCRIPTIVE STATISTICS FOR THOSE FARMERS *WITH* ACCESS TO CREDIT MARKET

<i>Variables</i>	<i>N</i>	<i>Mean</i>	<i>Standard Deviation</i>	<i>Min.</i>	<i>Max.</i>
Credit access (Yes/no)	115	1.00	0	1.00	1.00
Maintain business records (Yes/no)	115	0.42	0.50	0.00	1.00
Cattle (Head)	115	1.63	1.76	0.00	15.00
Farm size (Hectares)	115	1.04	1.90	0.05	16.00
Total revenues (000 Ksh)	115	123.75	116.73	8.20	730.00
Education of farmer (Years)	115	9.13	3.63	0.00	16.00
Distance to market (Km)	115	1.78	2.23	0.01	15.00
TIST member (Yes/ no)	115	0.68	0.47	0.00	1.00
Neighbor is TIST member (Yes/ no)	114	0.84	0.37	0.00	1.00

TABLE 2B. DESCRIPTIVE STATISTICS FOR THOSE FARMERS *WITHOUT* ACCESS TO CREDIT MARKET

<i>Variables</i>	<i>N</i>	<i>Mean</i>	<i>Standard Deviation</i>	<i>Min.</i>	<i>Max.</i>
Credit access (Yes/no)	15	0.00	0	0.00	0.00
Maintain business records (Yes/no)	15	0.47	0.52	0.00	1.00
Cattle (Head)	15	0.67	1.05	0.00	3.00
Farm size (Hectares)	15	0.61	0.99	0.05	3.60
Total revenues (000 Ksh)	15	45.62	33.71	10.00	120.00
Education of farmer (Years)	15	5.87	2.75	0.00	8.00
Distance to market (Km)	15	4.39	5.73	0.5	20.00
TIST member (Yes/ no)	15	0.53	0.52	0.00	1.00
Neighbor is TIST member (Yes/ no)	14	0.64	0.50	0.00	1.00

In a first step, we investigate determinants of credit accessibility in a logistic regression framework. Models 1 to 3 (table 3) establish the baseline model, where essential socioeconomic characteristics of smallholders are controlled for. For instance, a common result of all models indicates that collateral, such as the number of cattle in possession of the farmer improves the chances to access formal credit markets. We also control for the farmer's formal education, measured in years, which turned out to have a positive effect. The total revenues earned also seem to increase the probability to obtain credit at a formal credit institution, whereas distance to market consistently has the opposite result.

TABLE 3. DETERMINANTS OF ACCESS TO FORMAL CREDIT MARKETS AMONG KENYAN SMALLHOLDER FARMERS

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Maintain business records	0.31 (0.698)	-0.11 (0.711)	0.01 (0.736)	-0.87 (0.670)	-0.88 (0.665)	-1.23* (0.718)
Cattle (Head)	1.09* (0.660)	0.97** (0.490)	0.94** (0.557)	1.06** (0.495)	1.60* (0.889)	1.43* (0.808)
Farm size (Hectares)	0.93 (0.878)		1.07 (0.885)	1.10 (0.813)	2.18* (1.185)	2.09* (1.139)
Education of farmer (Years)	0.26*** (0.093)	0.19** (0.090)	0.19* (0.095)	0.26** (0.109)	0.15 (0.097)	0.14 (0.103)
Distance to market (Km)	-0.31*** (0.107)	-0.22** (0.096)	-0.29** (0.120)	-0.36*** (0.126)	-0.47** (0.192)	-0.46** (0.183)
Total revenues (000 Ksh)		0.01* (0.007)	0.02** (0.008)	0.02** (0.010)	0.02** (0.008)	0.02** (0.011)
TIST member (Yes/ no) – a				2.39*** (0.894)		15.87*** (2.179)
Neighbor is TIST member – b (yes/ no)					2.76*** (0.870)	2.65** (1.262)
Interaction TIST: a * b						-15.25*** (2.449)
Constant	-0.79 (0.906)	-0.71 (0.913)	-1.21 (0.854)	-2.92** (1.270)	-3.19** (1.308)	-3.38*** (1.281)
Observations	130	130	130	130	128	128

*Note: Robust standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Coefficients represent odd-ratios of a logistic regression where the dependent variable equals 1 if smallholder is a borrower, and 0 otherwise.*

Banks are likely to search for these characteristic among applicants for credit to identify farmers applying progressive production methods, generating higher and more stable incomes and therefore bearing a lower risk of default. Conversely, overall our results do not strongly support the hypothesis that maintaining business records is an important factor at the early stage of loan application; collateral substitutes and human capital seem to be of larger importance. In models 1 and 2, the baseline model is varied in such a way, that potential collinearity between farm size and total revenues become visible. The results of model 3 confirm those derived in models 1 and 2, indicating robustness and that collinearity between total revenues and farm size is not an issue here.

In a next step, the results of model 3 can be compared with those of models 4 and 5. The latter two models confirm earlier results, and allow investigating the effect of engaging extension and ecosystem services on the likelihood to access formal credit markets using TIST membership as a proxy. Model 4 controls for TIST membership of an individual and the corresponding coefficient suggests that TIST membership positively affect the probability to obtain credit. TIST membership is associated with a 2.76 higher chance to access credit market compared with non-members.

This may indicate that skills, information, and banking services (see Shames et al. 2012) training provided through the TIST network have a beneficial effect on credit access.

In model 5, the hypothesis is tested that it is not the membership per se that affects the ability to access credit, but is merely information, technology, etc. provided through the TIST network. Here, we do not control for TIST membership, but for the fact that an individual's *neighbor* is a TIST member. By performing this test we are able to separate the effect of formal membership and information transfer through the TIST network and subsequent spillover effect. The results indicate that the *neighbor's* membership also has a positive impact on an individual's ability to obtain credit, indicating that spillovers play a role in addition to returns to ecosystem services which are solely possible for formal TIST members. This phenomenon is not new to scientific literature as similar behavior has been observed for the Ghana, and Mozambique, but in this case the source for spillovers are not pioneering locals but an external institution (TIST), increasing skills by socializing knowledge and technology (Bandiera and Rasul 2006, Conley and Udry 2010). In model 6 we go one step further and control for TIST membership of an individual, TIST membership of its neighbors as well as an interaction term, which is supposed to identify cases when both individual and neighbor participate in TIST to further assess the relative importance of these factors. Our results suggest that when combining the effects of TIST and the interaction term the overall effect of TIST membership is still positive, but substantially smaller compared with the effect observed in model 4, and also smaller than the effect a neighbor's membership has on the likelihood to access formal credit markets. These results suggest that it is merely socialized knowledge and technology originating in the TIST program that drives this result rather than the formal membership per se.

In a second step, we only investigate farmers who have successfully applied for credit. We are particularly interested in the interest rate these individuals pay as differences in interest rates between individuals may help understanding differences in risk premia demanded by a credit institution. For the analysis of the determinants of credit interest rate, descriptive statistics are presented in table 4. Unfortunately, we lose those farmers without credit access and those with incomplete information on credit, resulting in 52 individuals to be used in empirical tests. Descriptive statistics indicate that the mean interest rate among the 52 smallholders who report credit access is 12.92 per cent per annum, with a reported minimum of two and a maximum of 20 per cent.² Explanatory variables were collected to capture smallholders' socioeconomic characteristics to assess their ability to check the risk of default as well as the credit institution's banking practices. Approximately 42 per cent of all interviewees confirmed that they maintained written business records, an activity which is central for a bank's client quality evaluation. As for collateral, average farm size totals 0.86 hectares, with a minimum of 0.1 and a maximum of eight hectares.³

TABLE 4. DESCRIPTIVE STATISTICS (REFER TO MODELS PRESENTED IN TABLE 5)

<i>Variables</i>	<i>N</i>	<i>Mean</i>	<i>Standard Deviation</i>	<i>Min.</i>	<i>Max.</i>
Credit interest rate (%)	52	12.92	5.34	2	20
Maintain business records (Yes/no)	52	0.42	0.5	0	1
Cattle (Head)	52	1.63	1.33	0	7
Farm size (Hectares)	52	0.86	1.26	0.1	8
Conventional credit institution	52	0.13	0.34	0	1
Microcredit institution	52	0.62	0.49	0	1
Co-operative bank	52	0.31	0.47	0	1
Income share from cropping	52	57.03	37.08	0	100
Income share from off-farm revenues	52	42.97	37.08	0	100
Income share from non-agriculture	52	43.18	27.21	0	100
Income share from ecosystem payments	52	1.00	2.53	0	13.33

Farmers kept on average 1.6 cattle on their farms while the most common credit source for loans is microcredit institutions (62 per cent). 31 per cent of interviewees reported practicing co-operative banking, while only 13 per cent are customers of conventional credit institutions. The contribution of on-farm revenue to total revenue averaged approximately 57 per cent which reaffirms the importance of (traditional) crop production in the income matrix of smallholders. The income share from agricultural off-farm revenues and non-agricultural activities is ca. 43 per cent.

The share of income from ecosystem services as a portion of total income, which should be an incentive for smallholders to engage in ecosystem conservation, is quite small. This may be due to the low PES (see also Shames 2013). On average, this source of income contributes only one per cent of total income. This finding is in line with that of Tschakert (2004) who found that the corresponding figures for Senegal ranges between 1 and 4.5 per cent. Two interviewees reported revenues from ecosystem conservation in the range of 12 to 14 per cent, indicating that among participants of ecosystem conservation practices there is still a large room for increases in income, collateral substitute (cash-flow), and act as a positive observable characteristics.

In table 5 the results of a set of OLS regressions are presented. The low number of observations complicates standard tests on statistical significance here. However, the signs and size of coefficients allow an evaluation of the

correlates of credit interest paid by Kenyan smallholders. Most importantly, farmers with the ability to maintain business records seem to experience a reduced interest burden compared to their peers who do not keep business records. The results indicate that microfinance and co-operative banks are willing to provide credit at lower interest rates if the borrower is able to provide transparency about his business by providing insights into the farm's financial situation. As for collateral, farm size is negatively correlated with lending rates, indicating that banks prefer real estate over other forms of collateral. The interest rate of credit granted decreases by approximately 1.2 to 1.3 per cent with every additional hectare of farm size, underlining the importance of collateral in the form of real estate. Conversely, the numbers of cattle owned by borrowers which may otherwise be accepted as collateral at the initial stage are not viable to interest rate at this stage as borrowers have to pay a premium for this form of collateralization. In parts of Ethiopia, the number of large animals owned by smallholder farmers was a determinant of access to credit which also increased the amount of sales of large animals, thus, justifying payment of a risk premium on such collateral (Tarozzi et al., 2014). The rationale behind the behavior of Kenyan banks may be explained by the fact that cattle may be sold, stolen or slaughtered.

We also include controls for other type of credit from conventional banks. The results suggest that loans taken out at conventional credit institutions are substantially more expensive compared to alternative forms of credit. Formal credit institutions in Eastern Africa appear to have strong preference for educated clients, collateral, liquidity and low-risk assets while advances to agriculture including smallholders are minimal. The result indicates that farmers with a large share of income from traditional cropping must pay more in interest. Conversely, the share of income stemming from off-farm revenues or non-agricultural activities – two metrics capturing very similar activities – and PES corresponds with lower interest rates. Interestingly, these shares of income are statistically insignificant. The orthodox interpretation of statistical significance of these coefficients would suggest accepting the hypothesis that this coefficient does *NOT* reflect a correlation between PES and more favorable credit terms. However, McCloskey and Ziliak (1996) argue that the concept of statistical significance is unreliable if the underlying number of observations is small, as it is the case here.⁴

In another set of regressions (not shown here) we additionally include control variables for loan size and physical height of an individual farmer. The rationale for the former is that interest rates on larger loans might be lower per unit borrowed, and hence constitute a potential explanatory factor of interest rate.

TABLE 5. DETERMINANTS OF CREDIT INTEREST RATE AMONG KENYAN SMALLHOLDER FARMERS

	Model 1	Model 2	Model 3	Model 4	Model 5
Maintain business records	-5.00*** (1.273)	-4.89*** (1.290)	-4.89*** (1.290)	-4.88*** (1.290)	-5.03*** (1.262)
Cattle (Head)	1.62*** (0.439)	1.54*** (0.436)	1.54*** (0.436)	1.54*** (0.436)	1.71*** (0.459)
Farm size (Hectares)	-1.21** (0.507)	-1.24** (0.523)	-1.24** (0.523)	-1.24** (0.522)	-1.19** (0.502)
Conventional credit institution	3.30* (1.930)	3.03 (2.030)	3.03 (2.030)	3.02 (2.031)	3.60* (2.008)
Alternative forms of credit	<i>reference</i>	<i>reference</i>	<i>reference</i>	<i>reference</i>	<i>reference</i>
Income from cropping (%)		0.01 (0.018)			
Off-farm revenues (%)			-0.01 (0.018)		
Income from non-agriculture (%)				-0.01 (0.018)	
Income from Ecosystem payments (%)					-0.21 (0.232)
Constant	12.98*** (1.201)	12.53*** (1.581)	13.58*** (1.396)	13.59*** (1.399)	13.00*** (1.213)
Observations	52	52	52	52	52
R-squared	0.29	0.30	0.30	0.30	0.30

Note: Robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The rationale behind using farmer's height as a proxy for health and human capital is that height is a function of nutrition, health, parents' education and related factors. Crucial period for the determination of final height are aforementioned living conditions around the time of birth and infancy. We believe that the nature of this metric limits the risk of reverse causality, and that height as a proxy for unobserved farmer quality limits the risk of omitted variable bias (Steckel, 1995; Case and Paxson 2008; Lundborg et al., 2014; Guven). However, including height of smallholder in the regression did not affect our results; the results remain virtually unchanged. Including this control, however, reduces our number of observations we therefore prefer to continue our analysis with our basic model as shown in table 5.

CONCLUSIONS

While the direct impacts of rural EES on living standards and ability to cope with climate change in sub-Saharan Africa is well understood, research on the other benefits relating to agricultural financing are limited. Farmers participating in EES may benefit from their observable characteristics — and thus creditworthiness — to financial institutions in order to

obtain access to credit and better credit terms. Improved credit market access may encourage the adoption of new technologies and strategies since increased monetary resources allow setbacks and shocks to be dealt with more flexibly

EES farmers may improve their chances of obtaining loans, amongst others, by gaining valuable physical collateral through PES as an acceptable form of loan securitization. In the theory section we utilize the model of Han et al. (2009) to show that EES can serve as a sorting mechanism for financial institutions to obtain information about a farmer's business and creditworthiness. We have also shown that credit contract separation improves the loan terms for farmers.

Moreover, empirical evidence for the existence of the game theory model implies that physical securitization and human capital may lead to separation equilibrium in credit contracts. In order to connect this hypothesis to a real-world scenario, data was collected from sustainable Kenyan smallholders participating in agroforestry project. Our results indicate that financial institutions are willing provide credit at lower interest rates if smallholders are able to maintain business records, which allow financial institutions to gain insight into the farming practices. Banks adjust the credit conditions according to the quality of the borrower's collateral; a low risk for default is observed if farmland can be offered as collateral, PES as form of collateral may result in low interest rates although statistically insignificant. Most importantly for this study, the empirical evidence suggests that smallholders pay a premium for traditional farming, with no income from sectors other than agriculture. EES activities seems to offer advantages in terms of less interest paid, as these types of programs can increase farmers' incomes and reduce the risk of credit default.

ENDNOTES

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¹ Note that if borrowers consciously engage in EES to get better credit terms, and this engagement is costly then we would have a signaling model. However, we do not model this decision and as such we are not dealing with a signal model

² We excluded those individuals who reported to have been granted credit from other sources, such as family members, friends, or other informal channels because we cannot tell whether these individuals are (formally) credit constraint or whether they chose to lend money informally for other, unobservable reasons.

³ 51 out of 52 interviewees reported to own the land they cultivate. One out of 52 reported to have only leased the land.

⁴ Keep in mind that irrespective of a dataset's data structure, large (small) numbers of observations lead to smaller (larger) standard errors.

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